

**CLAIMS**

1. An organic contaminant molecule sensor for use in a low oxygen concentration monitored environment, the sensor comprising an electrochemical cell comprising a solid state oxygen anion conductor in which oxygen anion conduction occurs at or above a critical temperature  $T_c$ , a measurement electrode formed on a first surface of the conductor for exposure to the monitored environment, the measurement electrode comprising material for catalysing the dissociative adsorption of the organic contaminant molecule, and a reference electrode formed on a second surface of the conductor for exposure to a reference environment, the reference electrode comprising material for catalysing the dissociation of oxygen to oxygen anions; means for controlling and monitoring the temperature of the cell; and means for controlling the electrical current flowing between the reference and measurement electrodes, whereby at temperatures below  $T_c$ , organic contaminant molecules are adsorbed onto and dissociated at the surface of the measurement electrode leading to the build up of carbonaceous deposits at the surface thereof, and at temperatures above  $T_c$ , an electrical current is passed between the reference and measurement electrode thereby to control the number of oxygen anions passing from the reference electrode to the measurement electrode to oxidise the carbonaceous deposits formed at the surface thereof and the formation of carbon dioxide.
2. A sensor according to Claim 1, wherein the measurement electrode is coated with or formed from material selected from the group comprising rhenium, osmium, iridium, ruthenium, rhodium, platinum and palladium and alloys thereof.

3. A sensor according to Claim 2, wherein the alloys include one or more elements selected from silver, gold and copper.
- 5 4. A sensor according to any of Claims 1 to 3, wherein the reference electrode is formed from material able to catalyse the dissociation of oxygen.
- 10 5. A sensor according to Claim 4, wherein the reference electrode is formed from platinum, palladium or other metal able to dissociatively adsorb oxygen or any alloy thereof.
- 15 6. A sensor according to any preceding claim, wherein the solid state oxygen anion conductor is selected from gadolinium doped ceria and yttria stabilised zirconia.
7. A sensor according to any preceding claim, comprising a counter electrode positioned adjacent to the reference electrode.
- 20 8. A sensor according to Claim 7, wherein the counter electrode is formed from platinum, palladium or other metal able to dissociatively adsorb oxygen.
- 25 9. A sensor according to any preceding claim, wherein the reference environment is a gaseous source of oxygen at atmospheric pressure, preferably atmospheric air.
10. A sensor according to any of Claims 1 to 8, wherein the reference environment comprises a solid-state source of oxygen.
- 30 11. A sensor according to Claim 10, wherein the solid state source is selected from a metal / metal oxide couple (optionally Cu / Cu<sub>2</sub>O or

Pd / PdO), or a metal oxide /metal oxide couple (optionally  $\text{Cu}_2\text{O}$  /  $\text{CuO}$ ).

12. A sensor according to any preceding claim, wherein the means for  
controlling or monitoring the temperature of the cell comprises a  
heater and thermocouple arrangement.
13. A sensor according to any preceding claim, further including means  
for providing a potential across the sensor.
14. Use of a sensor according to any preceding claim for monitoring the  
levels of trace organic contaminants in a low oxygen concentration  
monitored process environment.
15. A method of monitoring the levels of trace organic contaminants in a  
monitored process environment, the method comprising the steps of  
providing an electrochemical sensor comprising a solid state oxygen  
anion conductor in which oxygen anion conduction occurs at or  
above a critical temperature  $T_c$ , a measurement electrode formed on  
a first surface of the conductor for exposure to the monitored  
environment, the measurement electrode comprising material for  
catalysing the dissociative adsorption of the organic contaminant  
molecule, and a reference electrode formed on a second surface of  
the conductor for exposure to a reference environment, the reference  
electrode comprising material for catalysing the dissociation of  
oxygen to oxygen anions; exposing the measurement electrode at a  
sensor temperature  $T_{ads}$  to the monitored environment for a time  $t_{ads}$   
to cause one or more organic contaminant species to be adsorbed  
onto and dehydrogenate at the surface of the measurement  
electrode thereby leading to the build up of a carbonaceous deposit  
at the surface thereof; raising the temperature of the sensor to a  
value  $T_{lit}$  above the critical temperature  $T_c$  of the solid state oxygen

anion conductor and passing a current  $I_p$  between the reference electrode and the measurement electrode for a time  $t_p$  taken for the potential difference across the sensor to reach a constant value determined by the equilibrium between the flux of oxygen anions arriving at the electrode surface and the rate of desorption of oxygen gas from the electrode surface; and determining from the total charge ( $I_p t_p$ ) passed through the sensor at temperature  $T_{tit}$  the amount of carbonaceous deposit present at the surface of the measurement electrode and therefore the concentration of organic contaminant species present in the process environment.

16. A method according to Claim 15, wherein, subsequent to the adsorption step, the sensor is heated to a temperature intermediate  $T_{ads}$  and  $T_{tit}$  to facilitate the complete conversion of any uncracked hydrocarbon contaminant to a carbonaceous deposit on the surface of the measurement electrode, and thereafter the temperature of the sensor is raised to  $T_{tit}$ .

17. A method according to Claim 15 or Claim 16, wherein  $T_{ads}$  is in the range from 20 to 150°C.

18. A method according to any of Claims 15 to 17, wherein  $t_{ads}$  is in the range from  $10^2$  to  $10^5$  seconds.

19. A method according to Claim 18, wherein  $t_{ads}$  is of the order of  $10^4$  seconds.

20. A method according to any of Claims 15 to 19, wherein  $T_{tit}$  is in the range from 300 to 600°C.

21. A method according to any of Claims 15 to 20, wherein  $I_p$  is in the range from 10nA to 100µA.

22. A method according to any of Claims 15 to 21, wherein the sensor is provided with a counter electrode adjacent the reference electrode.

5 23. A method according to any of Claims 15 to 22, wherein the reference environment is a gaseous source of oxygen at atmospheric pressure, preferably atmospheric air.

10 24. A method according to any of Claims 15 to 22, wherein the reference environment comprises a solid-state source of oxygen.

15 25. A method according to Claim 24 wherein the solid state source is selected from a metal / metal oxide couple (optionally Cu / Cu<sub>2</sub>O or Pd / PdO), or a metal oxide /metal oxide couple (optionally Cu<sub>2</sub>O / CuO).

26. A method according to any of Claims 15 to 25, wherein a potential  $V_i$  is applied across the sensor.